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(54) **METHOD FOR ASSURING DEVICE ACCESS TO A BUS HAVING A FIXED PRIORITY ARBITRATION SCHEME**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

4,257,095	3/1981	Nadir .
4,785,394 *	11/1988	Fischer .
4,972,313 *	11/1990	Getson, Jr. et al. 710/125
5,204,951	4/1993	Keener et al. .
5,546,550	8/1996	Carter .
5,613,076	3/1997	Latif et al. .
5,715,406 *	2/1998	Henson et al. 710/107
5,754,887 *	5/1998	Damron et al. 710/39
6,016,528 *	1/2000	Jaramillo et al. 710/243

OTHER PUBLICATIONS

"SCSI Primer," *Understanding I/O Subsystems*, by D. Schwanderer and A. Wilson, Jr., chapter 7, pp. 113–131.
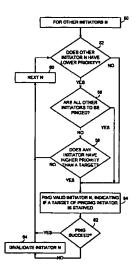
* cited by examiner

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(57) **ABSTRACT**

Computer-based devices, whether initiators or targets, are assured access to a bus having a fixed priority arbitration scheme (such as a SCSI bus) by assigning to each initiator a "fair share" of the bus bandwidth. This share is defined as a number of bytes per a unit of time such as a time period. The shares together total a fraction of the total bus bandwidth, with a margin of bus bandwidth left unassigned. To prevent initiator starvation, each initiator monitors its bus requests to determine if it is being prevented by higher-priority initiators from using its assigned share of the bandwidth. If not, the initiator periodically pings each higher-priority initiator to indicate that it is not being starved. So long as a higher-priority initiator continues to receive pings from all lower-priority initiators, the higher-priority initiator can continue to use as much bandwidth as it needs. If the higher-priority initiator fails to receive a ping from a lower-priority initiator, it stops sending new bus requests to the SCSI bus, making the bandwidth available to the lower-priority initiator. To prevent target starvation, each initiator monitors its outstanding bus requests to targets. If a request does not complete in an appropriate time, the initiator pings all other initiators with notification of target starvation. In response, all initiators limit their new bus requests to their share of the bandwidth. This limiting makes the unassigned margin of bus bandwidth available to the targets.

23 Claims, 9 Drawing Sheets